The Objective View April 2003

Newsletter of the Northern Colorado Astronomical Society

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Next Meeting: April 3 7:30 PM
Mysteries of Mars, Dr. Steve Lee
Curator of Planetary Sciences, DMNS
Destination Mars Exhibit open to members at 6:30 PM
NCAS Business at 7 PM

Meeting directions Discovery Science Center
703 East Prospect Rd, Fort Collins
http://www.dcsm.org/index.html
In Fort Collins, from the intersection of College Ave and Prospect Rd, head East about 1/2 mile. See the Discovery Center sign to the South. Enter the West Wing at the NE corner. From I-25, take Exit 268, West to Lemay Ave, continue West 1/2 mile, see Discovery Center on the left.

About Our April Program:
Dear NCAS members:
Discovery Science Center will be hosting a special event to highlight the Destination Mars exhibition on the evening of the April NCAS meeting. Dr. Steve Lee from the Denver Museum of Nature and Science will be lecturing on Mars exploration. He was a primary contributor of content for the exhibit. He'll discuss early telescopic and spacecraft observations of Mars as well as what new technology is revealing about the red planet. The museum will also be open to the public during this presentation so that visitors will have time to explore the traveling exhibit. We will open the doors for this evening program at 6:30 and stay open until after Dr. Lee's lecture is finished. As Discovery Science Center's honored guests we would like to invite all NCAS members to both attend the lecture and take the opportunity to explore the exhibit if you haven't already seen it free of charge. We will have the front doors of the science center open instead of the usual NCAS meeting room door. When you come to the front desk just mention that you are an NCAS member and we will waive the admission charge. Thank you for making NCAS such a dynamic organization. Discovery Science Center is thrilled to have such a wonderful partnership!
Sincerely,
Corey Radman
Museum Educator, Discovery Science Center, (970) 472-3992

Flash From The Moes:

To All,

As a very proud father, it is my pleasure to announce that my son, Max Moe, received a phone call this morning from Italy from Robert Gent, President of the Astronomical League, informing Max that he was selected by the Astronomical League to receive this year's National Young Astronomer Award (NYAA).

Max submitted his remarkable research project on "Demographic and Atmospheric Effects on the Quality of the Night Sky" in January and has been anxiously awaiting the judging ever since. A screening panel composed of amateur and professional astronomers reviewed all applications and selected ten finalists. From these ten, Max was selected by a national panel of professional astronomers as the winner.

As this year's winner, he is invited to attend an all expense paid trip to the 2003 Convention of the Astronomical League in Nashville, Tennessee, July 9th-12th. As the first place winner, he will receive a first place plaque and a Meade 10-inch LX-200 Schmidt-Cassegrain Telescope. In addition, he will receive from the University of Texas McDonald Observatory a "Lifetime Pass" allowing him to share telescope time with professional astronomers at the observatory.

As proud parents, we cannot begin to convey our joy for Max! We want to also thank all of you who have encouraged him and his passion.

Ray and Lorraine Moe

NCAS Star Party Dates
April 4, 5, 25, 26
Cactus Flats site is on undeveloped parcel of prairie about 6 miles West of Briggsdale. Take Colo Hwy 14 East from I-25 (Exit 269). Go 19 miles East to Ault. Continue 18 miles East of

Ault. At County Rd 65 (Milepost 170), turn North, go one mile. Site is through the wire gate on the right, no road, close gate and set up. Beware of the cactus. Our standard nights are the weekend of the New Moon, sometimes a weekend before and after. The site is now officially wheelchair accessible, but there are no facilities so bring essentials. Call **Tom Teters, starmon@jymis.com,** with questions about star party status or dates, 482-5702 or 482-0807.

Discovery Science Center Starwatching
April 4 7:30 pm
May 9 8:00 pm

Rocky Mountain National Park Starwatching 2003
Contact Dan Laszlo, djlaszlo@aol.com, if you wish to volunteer with your telescope for programs in the park this summer. Dates are: June 6, June 22, July 18, July 25, August 1, August 22. A weather cancellation message can be consulted at 472-3990 after 5 PM.

Longmont Astronomical Society 1st Quarter Moon Public Viewing Nights, Flanders Park
April 5

Other Events

Little Thompson Observatory Star Night, Berthoud
April 18 Star Night 7 – 10 pm
Rich Reinert: Deep Impact Mission to Comet Tempel 1
http://www.starkids.org

Cheyenne Astronomical Society
April 18 Cheyenne Botanical Garden 7PM
http://home.attbi.com/~curranm/

Open House, Chamberlain Observatory, dusk to 10 PM
April 5 303 871 5172
http://www.du.edu/~rstencel/Chamberlin/

Longmont Astronomical Society
April 17, Longmont Christian School, 550 Coffman St
http://laps.fsl.noaa.gov/cgi/las.cgi

North Sterling Star Party April 26

March 6 Program
Jupiter and Saturn
Dr Roger Culver, CSU

Jupiter and Saturn are well placed for observing this Spring, high in the sky in the first half of the night. Jupiter puts on the best show of all planets, It is large, its oval shape obvious, and it is accompanied by the varying patterns of its four largest moons. Jupiter spins with a 9 1/2 hour day, flattening its pole and bulging its equator. Clouds at the equator move at 25000 mph with the planet's rotation. The Great Red Spot is a gigantic hurricane, as wide as 1 1/2 Earths. It has been raging for hundreds of years at least. The earliest spacecraft images from the Pioneer probe showed Jupiter's 3D aspect. Voyager probe images impressed Roger that Jupiter vistas illustrated by sci-fi artists like Chesley Bonestell. Sequential images captured daily changes in the swirling Jovian atmosphere. As Voyager viewed Jupiter's dark side, lightning strikes were recorded. These were the source of long-unexplained radio outbursts. Jupiter captured Comet Shoemaker-Levy 9 and it's impact was comparable to an extinction-level impact in Earth's history. Jupiter's clouds bore disruptions the size of Earth. Energy from the comet's impact totaled an order of magnitude greater than the totaled thermonuclear devices of Earth. Jupiter is believed to contain a rocky/metallic core, surrounded by metallic hydrogen. There is a thick layer of liquid molecular hydrogen, covered by an atmosphere containing ammonia and other nitrogenous molecules, and water. Jupiter is radiating more energy than it receives. Heat remaining from the time of Jupiter's formation is believed to be slowly leaking out. The Galilean satellites are Jupiter's 4 major moons. Kalahari bushmen have seen 1 or 2 without optical aid. In 1609, Galileo interpreted Jupiter and its shifting moons as a miniature solar system. Each has it's own personality. In March, April and May, the moons' orbits are aligned for us, and we see mutual satellite phenomena, eclipses and occultations. Sky & Telescope magazine is a source for predictions monthly. Jack Horkheimer, PBS' Star Gazer, promotes "I Eat Green Caterpillars" to recall the sequence Io, Europa, Ganymede, Callisto in increasing orbit radius. Io is distinctly unlike our Moon. No impact craters dot the surface. It is continuously renewed with eruptions of sulfur compounds from its 60 volcanoes. Plumes have been detected from Earth. Europa has ice over liquid. The surface shows fracture patterns like sea ice in the Arctic. There is likely more liquid water on Europa than the total in Earth's oceans. Since discovery of ecosystems around thermal vents in black ocean depths on Earth, Europa is a target for the search for life in the Solar System. A probe might have to puncture 1-2 miles of ice to reach the liquid. Ganymede is the 3rd largest satellite in the Solar System. It has a weak magnetic field. This may be generated by a saline solution as the moon spins, or a magnetic core. It is relatively dark, albedo 0.2. Callisto retains impact craters in its icy surface. Craters are small, compared to Earth's Moon. Jupiter has over 40 satellites, mostly captured pieces of junk. Saturn's peculiar nature was suspected in 1633. Galileo drew it as a circle flanked by smaller disks. In 1634 it was seen as a large oval. The oval later looked punctured by 2 black diamond shapes toward its ends. In 1656, it looked like the circle again. Huygens recognized Saturn's ring encircling the globe. It remains on everyone's top 10 list of exquisite objects. Saturn's atmosphere is like Jupiter's. Convection and rapid rotation drive jet streams. It is 95x the mass of Earth, 10x the diameter of Earth. Density is very low, 3/4 gram/cm^3. It would float on water. It spins once in 10 1/2 hours. There is belt and band detail in the clouds. It has faint storms, "Red Spot Wannabes." Its insulating metallic hydrogen layer is much smaller than Jupiter's. Saturn's energy emission cannot be blamed on primordial heat. Saturn has auroras, and helium rain through the hydrogen atmosphere. Saturn has over 33 satellites. Mimas has

a huge crater named Ulysses, and was nearly split by the impact. Dione looks like beat up rocks. Titan is 8th magnitude, always visible in small telescopes. It is the only moon with a significant atmosphere. A thin blue shell was seen by Voyager, looking at backlit Titan. It contains methane, N_2, and aerosols. It is near the triple point of methane, and theorists wonder if life might exist adapted to the methane cycle. Saturn's axis is tilted like Earth's. The rings range from invisible in small telescopes, to beautifully encircling the globe. The planet is near perihelion and the rings are at their best within the next year. For many years, the rings were thought to be debris from a satellite that ventured inside the Roche limit and disintegrated. The A ring extends 200,000 km and is 5-6 km thick. A piece of Saran wrap the size of Larimer County would have similar proportions. Voyager images showed the rings divided into hundreds of shifting ringlets. They can contain braided structures and sometimes show spokes. They are a source of torment for theoreticians. The rings of Uranus were discovered about that time, as observers monitored its passage by a star, and detecting unexpected drops in starlight. Roger's favorite Saturn image is from Voyager II, showing the planet illuminated from the side. The unearthly perspective recalled memory of a Chesley Bonestell painting. We are awaiting the arrival of the Cassini spacecraft. Cassini recently returned an image of a gibbous Saturn. In January 2005, it will deliver an instrument package to Titan, exciting times for planetary astronomers.

NCAS Business
President Dan Laszlo called the meeting to order. Max Moe, Vice President, announced upcoming programs. Nate Perkins, Treasurer, gave his report and circulated a member list with dues status. Gerry Reynolds proposed that an increase in club dues be considered, and this was discussed. Fundraising would be necessary for any substantial expenditures. Brad Jarvis invited members to the upcoming Mars Society program. Dan Laszlo invited members to join the public starwatch on March 7.

Scope for Sale
Coulter 10 inch Dobsonian. Like new. Includes Kellner eyepiece, eyepiece rack, red-dot aiming device, aperture stop, dustcap. $600. Call Gene, 970-568-0545.

Scope for Sale. 10" f8 home assembled Newtonian. Excellent precision mirror by Galaxy Optics, made about 1985, optimal size high precision quartz secondary. Scope is optimized for planetary imaging, gives truly excellent images. Sonotube, Novak mirror cell and spider . Homemade focuser 1.25". Finder is half of a binocular; wooden mount a bit clunky, but it works. 12 and 24mm University Konig eyepieces included. $600 complete, Steve Smith (970) 663-1513 (Loveland).

Clear Sky Clocks for Colorado
http://cleardarksky.com/csk/prov/Colorado_clocks.shtml

From Jim S: Best Moon Site I've Seen:
http://www.moon-phases.com/

Best Looks

Moon		by Saturn 4/7, by Jupiter 4/10
		by Mars 4/23, by Venus 4/27,
Mercury		Low in W, evenings, second week of month
Venus		low in SE predawn
Mars		In SE predawn
Jupiter		By Beehive cluster April 3-4
	Apr 11	2136 MDT Ganymede partially eclipses Io
Saturn		Near overhead at sunset
Uranus		In Aquarius predawn
Neptune		In Capricornus predawn

14th Magnitude Supernova in Sextans Galaxy

Issued 24 March, 2003:

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
25 Birch Street, Cambridge, MA 02138 USA
INTERNET: aavso@aavso.org
Tel. 617-354-0484 Fax 617-354-0665

AAVSO ALERT NOTICE 300 (March 24, 2003)

SUBJECT: 1009+03B SUPERNOVA 2003CG IN NGC 3169

1009+03B SUPERNOVA 2003CG IN NGC 3169 (SEXTANS)

Event: Supernova

Independently Discovered By: K. Itagati, Teppo-machi, Yamagata, Japan; R. Arbour, South Wonston, Hampshire, England (IAUC No. 8097)

Discovery Magnitude: 14.4 unfiltered CCD (0.60-m f/5.7 reflector, Itagati);
14.5 unfiltered CCD (0.30-m f/6.3 reflector, Arbour) (IAUC No. 8097)
Discovery Date: March 21.51 UT (Itagati); March 22.835 UT (Arbour) (IAUC No. 8097)
R.A. of NGC 3169 (2000): 10h 14m 15s.97
Decl. of NGC 3169 (2000): +03o 02.5' 14".4 (IAUC No. 8097)
Supernova Position: 14" east and 5" north of the nucleus of NGC 3169 (IAUC No. 8097)

AAVSO Chart(s): 'f'scale chart
for full 300 dpi image
http://www.aavso.org/charts/SEX/NGC_3169/SN2003CG-F.GIF

for web browser printable image
http://www.aavso.org/cgi-bin/shrinkwrap.pl?path=/charts/SEX/NGC_3169/SN2003CG-F.GIF

Report Object to the AAVSO as: 1009+03B SN 2003CG

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Observations Reported to the AAVSO: March 13.3 UT, <19.0: CCD, K. Itagati,
Teppo-machi, Yamagata, Japan; 22.3, 14.9 CCD, Itagati; 22.444, 14.3 CCD, Itagati; 22.559, 15.5 CCD through clouds, Y. Kushida, Yatsugatake South Base Observatory; 24.1368, <14.9, M. Simonsen, Macomb, MI. (All observations from IAUC No. 8097, except the last reported to AAVSO HQ by M. Simonsen.)

Notes:

1. M. Simonsen reports that supernova is currently difficult to observe with a 12" telescope and suggests that since the object is so close to the nucleus of NGC 3169 and since the galaxy is bright, it might become more apparent once it rises to a visual magnitude of ~14.5.

2. SN 1984 E also appeared in NGC 3169.

3. See the full announcement in International Astronomical Union Circular (IAUC) No. 8097.

SUBMIT OBSERVATIONS TO THE AAVSO

We encourage observers to submit observations via our web site (online data submission tool WebObs), or by email in AAVSO format to observations@aavso.org. If you do not have AAVSO Observer Initials, please contact Headquarters so we may assign them to you. The answering machine at
AAVSO Headquarters is on nights and weekends; use our charge-free number (888-802-STAR = 888-802-7827) to report your observations, or report them via fax (617-354-0665).

Many thanks for your valuable astronomical contributions and your efforts.

Good observing!

Janet A. Mattei
Director

From Brad Jarvis:
MarsNews.com will present weekly broadcasts of our hour-long program "Radio Free Mars" starting Tuesday, March 18th. The program will feature a weekly space newscast, information on past, present, and future missions to Mars, and phone interviews with newsmakers and space experts. The program will be hosted by James Burk, Editor-in-chief of MarsNews.com, an expert on the Red Planet and the past President of the Mars Society's Seattle chapter.

The broadcasts will be aired on ZeroPointRadio.com, an internet radio network and will also be available for listening & download at the following address:
http://www.marsnews.com/radio/

Radio Free Mars is a production of MarsNews.com in cooperation with the Mars Society's Radio Free Mars task force. The first two broadcasts of Radio Free Mars from last fall are available for download at the website above.

Iridium Flares Viewed from ISS
Hats off to Rob Matson! He has created a customized program that allows predicting Iridium flares as seen from the ISS, and it works!. Think about that.... predicting the interception of an Iridium flare moving at 5 mi/sec as seen from another platform in space also moving 5 mi/sec in a different plane. It boggles the mind.

Anyway, a few weeks ago Rob offered to code up such a program if the guys aboard the ISS were willing to look for flares. Sounds simple enough....its never cloudy up there and its night time every 45 minutes. But astronomical observations from the ISS are complicated. Limited viewing angles through the various windows, which may or may not be oriented toward the stars, and reflections from station modules and panels which make observation of stars impossible when in sunlight have to be taken into account. I sent Don Pettit a note offering to forward any of Rob's predictions and by golly, they went for it.

So Rob coded up the program and I have sent up a number of his predictions that Rob filtered for the station's limited viewing angles. After several missed opportunities because of work schedules and solar illumination constraints, Don Pettit had a hit today! The ISS successfully intercepted a predicted Iridium flare and it was observed by the Science Officer.

Here is part of a note I got from Don on the ISS this evening.....

****

I have been having a great time looking for the IR flashes. So far I have seen one of the predicted events. The other flashes were predicted to be much weaker and came at a time when sunlight was still falling onto parts of station hence spoiling viewing contrast. If the flashes were a few minutes later, it would have been dark and I probably could have seen them.

March 5th the 10:15 flash at -8: I looked at my watch after the flash and it was 10:16:24. I estimate the flash to be about -1 magnitude based on the stars around. It was weaker than the pointer stars next to the Southern Cross. I was watching out the US Lab window at quite an angle. The flash was near the two pointer stars next to the southern cross and was at about RA 230 Dec -50. You should have seen the smile on my face when I saw this. Great job on the calculations.

This afternoon we changed attitudes again. We are now LVLH which keeps the same side of station pointed towards Earth. Great for Earth observations but bad for stars since most of our windows point "nadir". However, we have two small windows in the Russian segment which point starboard and port to our velocity vector so when we are at our highest and lowest latitudes, we have views looking due north and south. This should be good for seeing IR flashes since they give views where the satellite orbits converge. They are also great for aurora. After we get good at predicting and seeing these then I will set

up a camera and record them. Maybe I can get a flash with aurora!

Anyway, good work. If it is not too much trouble, please keep the predictions coming. I will take the time to view as many as I can. For the time being, let us concentrate on brighter ones, say less than 0 mag.

take care

Don

****

I say this is way cool! Its not every day that someone from the amateur community creates something that is used by the guys up in the big bed and breakfast in the sky. I'd say we owe Rob a cold beer on the house!

Robert Reeves

Photo of Iridium flare from ISS on the ISS Science Picture of the Day, and current day's image:
http://science.nasa.gov/ppod/y2003/28mar_iridiumflash.htm
http://science.nasa.gov/ppod/default.htm

On 2/25 Robert Fenske, Jr. posted the following URL
http://spaceflightnow.com/shuttle/sts107/030225amos/visible.html which shows a remarkable image of the Columbia taken on Jan 28. The telescope that took the picture was on Maui at an observatory with a geodetic altitude of 3,058 meters. After much searching I finally located the observatory's coordinates. They are 156:15:29 West and 20:42:31 North. The UTC offset is -10 hours.

I looked at the pictures and noticed what looked like low angle direct sunlight on the nose and other places and what appeared to be a low contrast illumination that looked like what would be caused by "earth shine" on the rest of the craft. That made me wonder if this picture was shot during daylight in what would have been, as seen from that observatory's altitude, a deep blue sky. On the picture itself is the following information: STS-107 28 Jan 2003 21:49Z. If the 21:49Z means 21:49 UTC the photograph was taken at 11:49 AM local time, right?? That time I do not think would not provide the correct angle of direct sunlight.

In an attempt to double check the time that the picture could have been taken I looked up an archived TLE for the Shuttle that day and plugged it into my planetarium software. The TLE I used follows:
1 27647U 03003A 03028.25000000 .00065526 72042-5 11773-3 0 506
2 27647 39.0185 151.7164 0008975 103.0922 196.3708 16.00992267 1855

I ran a check and determined that the best possible pass over Maui was around 16:46:00 local time. At that time the shuttle was generally SE and was about 57 degrees in altitude; the sun was also at the proper angle for producing the glare that the image shows and the earth below would have been well illuminated.

I welcome comments on my analysis. I may have made a serious error because this type of analysis is quite new to me.

In doing the research I have learned much about the satellite tracking systems at the Maui site. They are impressive to say the least. If you are interested you can begin by doing a Google search for "MAUI SPACE SURVEILLANCE SYSTEM (MSSS) SENSORS" then click on "cache" otherwise you will get an error message.

A system called GEMINI can produce images of satellites even in daylight conditions. There you have it! That must be what they did when photographing the Shuttle. Some of the telescopes are even fitted with lasers that can illuminate LEO satellites during the time they are in shadow!

There is also a telescopic setup called the, "Contrast Mode Photometer (CMP)" that is very impressive. The article reads, "because of its large, twenty stellar magnitude dynamic range, the CMP is particularly useful for observing specular glint measurements from artificial satellites illuminated by the sun. An example of a photometric signature obtained from a geostationary satellite is shown in Figure 5. Much can be learned about the configuration and dynamics of an unknown satellite by studying the glints in CMP signatures. Uniform repetition of glints might indicate rotation of the object which can indicate that it is spin stabilized or has gone unstable.
Motions and configuration can also be determined through analysis of the more slowly varying diffuse component of an optical signature."

The manual for the AMOS telescope system is very informative too. It can be obtained here:
http://www.maui.afmc.af.mil/AMOS/AMOS_UsersManual_02.pdf It's only 16MB and 117 pages long! :~)

One last thing for any stereo enthusiasts. The last of the three visible light pictures of the shuttle can be stereofused with the first or second image to produce a crude 3D image. I placed the last image to the right of the other ones and used the cross-eyed method to see the third dimension.

Clear skies!

Tom
Iowa
USA

Foam is Worse Than Ice, from Rob Matson
Terry asked:

> I don't get this. For a piece of material to separate from
> the tank and strike at 643 fps after say, 50 feet of travel,
> it would have to decelerate at an average of 144 Gs for

> about .15 seconds. Does that seem likely? Especially for
> something dense, like ice or aluminum?

For insulating foam -- yes; for ice or metal, no. That's what's interesting and perhaps non-intuitive about the debris impact problem: the lighter weight, high area-to-mass ratio material is going to cause more damage than smaller, denser material like ice. The instantaneous deceleration is:

1/2 * Cd * A/m * rho * v^2

where Cd is the drag coefficient, A is the projected area of the debris in the velocity vector direction, m is the mass, v is the atmospheric velocity of the Shuttle at the time the debris came off, and rho is the density of the atmosphere at the Shuttle's altitude. However, v is rapidly decreasing in time, so the deceleration due to drag also falls off rapidly. Because of that (Cd*A/m) term, the ice deceleration is going to be much much slower than that for the foam debris. So while the mass of ice debris would certainly be greater for a comparable-sized piece, the impact energy is proportional to m*(v^2). For the sizes we're talking about, the foam is going to have more kinetic energy.

It would be an interesting exercise to compute the worst case material density from an impact perspective. --Rob

Shuttle probe follows a trail of data

Detailed timeline of last moments could shed light on causes
By James Oberg
NBC NEWS SPACE ANALYST

HOUSTON, March 16 — Investigators looking into the loss of the shuttle Columbia and its seven astronauts on Feb. 1 are putting the finishing touches on the collection of raw data from the final moments of flight. Now their analysis is shifting to interpreting those findings and "walking back" the reconstruction of these events to try to find the cause of the catastrophe.

LABORIOUS DECODING EFFORTS have revealed much about the last 32 seconds of telemetry signals sent back in a form too garbled to be understood in real time. Results of this analysis were contained in two "timelines" released last week.

Furthermore, sources within the investigation have told MSNBC.com that investigators hope an avionics box recovered several weeks ago may contain critical data about the exact moment Columbia broke apart. Part of the shuttle's Global Positioning System receiver, the device has been sent to the vendor in Iowa in an attempt to read the last "state vector" — the precise position and time when the power was cut off by the cabin's separation from the rest of the fuselage.

Telemetry from the shuttle details a graphic sequence of events as Columbia's autopilot struggled to maintain control against the growing air drag on its left wing. In the final seconds, the shuttle was already tumbling and pieces were breaking off.

MSNBC.com first described these preliminary interpretations on Feb. 24, based on sources familiar with the investigation. But for two weeks afterward, representatives of the Columbia Accident Investigation Board continued to say the data they had seen showed that the shuttle was flying under control of its aerosurfaces and steering thrusters right up until the end of data transmission. These most recent timelines now show this could not have been true.

INTERRUPTED COMMUNICATIONS

During entry into the atmosphere, communications between Columbia and Mission Control in Houston were transmitted via a relay satellite high over the Pacific Ocean. Ionized plasma surrounded the spacecraft and blocked direct radio transmissions from the shuttle to the ground, creating a "blackout" during this period. But the plasma was thinner above and behind the shuttle, and for the past dozen years or so NASA has adapted its space-to-space communications relay system to circumvent the blackout effect.

Normal communications with Columbia were maintained until 7:59:32 a.m. Texas time. Since the shuttle was in a steep left bank and the relay satellite was "setting" — getting low to the horizon — the line of sight from the transmitter to the satellite passed near the shuttle's tail. As a result, the signal was interrupted. NASA operators, aware of this geometric relationship, were not alarmed at first. But the radio link was never fully restored, even though some unreadable data was recorded at a ground station.

The first five seconds of garbled data were later reconstructed by analysts. It shows that the autopilot declared a "Master Alarm," but the exact code could not be read. This told the crew that something was seriously wrong.

Analysis also shows that the shuttle's orientation began to shift, with the "sideslip" — the direction of air across the wings — changing by several degrees. "[Autopilot] drops left wing to compensate for increasing aerodynamic [twist]," NASA's timeline notes. The shuttle was also firing two steering jets to keep the nose from being pulled to the left.

In a last desperate attempt to maintain proper pointing, the autopilot activated two more steering thrusters, all it had available. The ailerons on the wings were commanded to higher and higher deflection, until the very last indication. "The rate of change had reached the maximum allowed," says the report. Then — silence. No signal at all, not even a garbled one, was received.

All investigators who have talked with MSNBC.com privately presume that this total radio cutoff indicates the shuttle had begun veering to the left. This could have pointed its antenna away from the relay satellite.

MESSAGES WITHIN GARBLED DATA

Twenty-five seconds later, at just three seconds after 8 a.m. CT, a final two-second burst of garbled data began. It contained information about Columbia's current situation, as well as a log of error messages that had been sounded during the 25 seconds of total silence.

Nine seconds into the silence, the computers had sounded a "Roll Reference" alarm, which informed the crew that the autopilot was having difficulty keeping the shuttle in proper roll orientation. "Message generation less than ten seconds after start of [all] yaw jets firing suggests rapid change in Lift to Drag

ratio," NASA's report states. In plain English, the shuttle was literally changing shape, and the computers knew it.

Within seconds, a series of error messages came from Columbia's left thruster pod, atop the fuselage back at the base of the tail. Thrusters were leaking, then fuel tanks were leaking, and finally most of the telemetry readings from the entire pod went out.

The most common interpretation for these readings and for ground observations is that the left wing folded up, impacting the thruster pod. Within seconds, according to NASA's report, "Large debris [was] seen falling away from the Orbiter."

This was probably the wing, which held together most of the way down, as shown by the small "scatter" pattern of pieces that were later recovered.

Without the left wing, the shuttle would be twisted into a hard left roll under the lift forces from the right wing. Combined with the left yaw that began soon after its thrusters and ailerons lost their battle to preserve stability, this would create a rapid end-over-end cartwheel motion.

NASA's reconstruction of the last two seconds was expressed in dispassionate engineering terminology that could not disguise the horrible situation. "Data suggests vehicle was in an uncommanded attitude," the report states, "and was exhibiting uncontrolled rates." Sensors for angle rates have a maximum value of 20 degrees per second, and the yaw sensor reading was "pegged high" — the actual rate could have been much higher. The pitch and roll rate measurements were unreadable but probably below the maximum value.

The report confirmed earlier partial announcements that the shuttle's hydraulic power system had totally failed, with zero pressure and fluid levels in all three systems. This is another indication that the left wing was totally gone.

Although the autopilot was still in command of the shuttle, there is some indication that one of the control sticks was deflected, an action that can return the computers to manual mode. But it's equally possible that the deflection was caused by an inadvertent bump by one of the pilots' knees.

FINAL BREAKUP

Thirteen seconds after the end of this burst of data, video taken from the ground shows more big pieces coming off the main body of the shuttle. Forty miles high, Columbia was crossing Interstate 45 just north of Corsicana, Texas. The NASA report specifies "Vehicle Main Body break-up" at between 21 and 25 seconds after 8 a.m. CT.

More precise timing of the breakup may be extracted from the Global Positioning Satellite unit recovered two weeks after the crash. According to reports from independent sources familiar with the investigation — but unconfirmed by the Columbia Accident Investigation Board — the unit was in such good shape that its emergency battery may have preserved the last frame of data prior to loss of electrical power. Reportedly the unit has been shipped to the vendor in Iowa for data recovery.

Since power to the crew cabin is provided from fuel cells underneath the shuttle's payload bay in the mid-fuselage, investigators tell MSNBC.com that the moment of power loss would probably coincide with the time the fuselage broke into pieces.

Reconstruction of what became of Columbia's pieces and contents after breakup will require analysis of the scatter patterns and physical conditions of related items on the ground. The Columbia Accident Investigation Board has told NBC News that this has not yet been done.

But a more precise understanding of the final moments of the shuttle's flight, developed through data analysis, is proving useful in deducing what physical abnormalities were present, based on a much more detailed understanding of their effects on Columbia's flight. Experts associated with NASA and the Columbia Accident Investigation Board are now focusing on an assessment of how these abnormalities originated and developed.

James Oberg, space analyst for NBC News, spent 22 years at the Johnson Space Center as a Mission Control operator and an orbital designer.

From: Dan Laszlo
2001 S Shields St Building H
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TO:

International Space Station Passes for Loveland-Fort Collins April 2003

Local Time: Mountain Standard Time (GMT - 7:00)

Date	Mag	Starts			Max. Altitude			Ends		
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
29 Mar	2.2	20:09:24	10	NW	20:11:17	15	NNW	20:12:50	11	NNE
30 Mar	1.8	19:11:32	10	WNW	19:13:58	20	NNW	19:16:24	10	NNE
30 Mar	2.6	20:49:56	10	NNW	20:50:34	11	N	20:50:34	11	N
31 Mar	2.4	19:52:09	10	NW	19:53:34	12	N	19:55:00	10	NNE
01 Apr	2.1	18:54:09	10	NW	18:56:06	15	NNW	18:58:04	10	NNE
01 Apr	2.3	20:32:02	10	NNW	20:33:17	12	N	20:33:21	12	N
02 Apr	2.4	19:34:36	10	NNW	19:35:43	11	N	19:36:50	10	NNE
02 Apr	2.9	21:10:38	10	NNW	21:10:47	11	NNW	21:10:47	11	NNW
03 Apr	2.1	20:13:40	10	NNW	20:15:19	13	NNE	20:15:48	13	NNE
04 Apr	2.2	19:16:30	10	NNW	19:17:41	12	N	19:18:52	10	NNE
04 Apr	2.2	20:52:02	10	NNW	20:53:07	17	NNW	20:53:07	17	NNW
05 Apr	1.7	19:55:00	10	NNW	19:57:08	17	NNE	19:58:04	15	NE

MDT = GMT – 6h

06 Apr	2.0	20:57:54	10	NNW	20:59:28	13	N	21:01:02	10	NE
06 Apr	1.1	22:33:18	10	NW	22:35:19	29	N	22:35:19	29	N
07 Apr	1.2	21:36:09	10	NNW	21:38:42	22	NNE	21:40:14	16	ENE
07 Apr	2.6	23:11:56	10	WNW	23:12:34	15	WNW	23:12:34	15	WNW
08 Apr	**-0.5**	**22:14:28**	**10**	**NW**	**22:17:29**	**65**	**NNE**	**22:17:29**	**65**	**NNE**
09 Apr	0.5	21:17:09	10	NW	21:20:04	33	NNE	21:22:24	14	E
09 Apr	1.9	22:53:23	10	WNW	22:54:44	19	W	22:54:44	19	W
10 Apr	**-0.4**	**21:55:35**	**10**	**WNW**	**21:58:43**	**61**	**SW**	**21:59:41**	**38**	**SSE**
11 Apr	**-0.4**	**20:58:03**	**10**	**NW**	**21:01:10**	**59**	**NNE**	**21:04:17**	**10**	**ESE**
11 Apr	2.0	22:35:13	10	W	22:36:56	14	SW	22:36:59	14	SW
12 Apr	0.9	21:36:44	10	WNW	21:39:33	30	SW	21:42:00	12	SSE
14 Apr	2.1	21:18:08	10	W	21:20:08	16	SW	21:22:09	10	S

A Few Iridium Flares For Lemay and Trilby, Fort Collins
Local Time: Mountain Standard Time (GMT - 7:00)

Date	LocalTime	Magnitude	Alt.	Azimuth	Distance to flare centre	Intensity at flare centre	Satellite
03 Apr	04:47:38	-7	28°	18° (NNE)	6.0 km (E)	-7	Iridium 11
04 Apr	04:41:45	-7	26°	18° (NNE)	3.9 km (W)	-7	Iridium 3

Local Time: Mountain Daylight Time (GMT - 6:00)

07 Apr	22:02:41	-7	54°	104°(ESE)	5.3 km (W)	–8	Iridium 37